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Epitome

(57) [Abstract]

[Objects of the Invention] Return the light which came out of the light source and spread the fiber coil to the circumference of a clock, and the circumference of an anti-clock to the light source, and make structure of a depolarizer simpler in the current of a light emitting device, electrical-potential-difference change, and the optical fiber gyroscope that asked for angular velocity from the photocurrent of the photo detector for monitors.

[Elements of the Invention] The birefringence medium whose difference of the optical path length over an ordinary ray and an extraordinary ray is more than the coherence length of the light source is formed between a fiber edge and the light source. When the light source gives off a non-polarized light, bearing of a birefringence medium is arbitrary. When the light source gives off the linearly polarized light, the main shaft of a birefringence medium accomplishes the include angle of 45 degrees to the linearly polarized light. When preparing a polarizer, it installs so that the main shaft of a birefringence medium may accomplish the include angle of 45 degrees to the transparency shaft of a polarizer.

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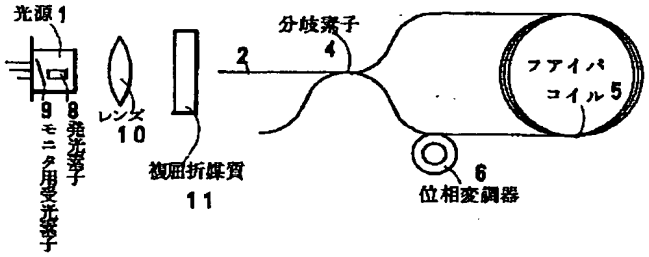

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CLAIMS

[Claim(s)]

[Claim 1] The light source containing the photo detector for monitors which is prepared the light emitting device which generates the homogeneous light or quasi-monochromatic light, and behind this, and supervises the luminescence reinforcement of a light emitting device, The fiber coil around which the single mode fiber was wound about many times, and the branching component which carries out light which came out of the light emitting device for 2 minutes, and is led to the ends of a fiber coil are included. Branch the light which came out of the light emitting device, and a fiber coil is made to spread to the circumference of a clock, and the circumference of an anti-clock. It asks for the luminous intensity which returned to the light source according to change of own operating state of a light emitting device, or the photocurrent of the photo detector for monitors. It is the optical fiber gyroscope which asked for the angular rate of rotation of a fiber coil from the phase contrast of the circumference light of a clock, and the circumference light of an anti-clock. The optical fiber gyroscope which takes out a signal from the light source characterized by making light by which the optical path length's difference over an ordinary ray and an extraordinary ray forms the birefringence medium which is more than the coherence length of a light emitting device between a branching component and the light source, and passes along a birefringence medium no polarizing.

[Claim 2] The light source containing the photo detector for monitors which is prepared the light emitting device which generates the homogeneous light or quasi-monochromatic light of the linearly polarized light, and behind this, and supervises the luminescence reinforcement of a light emitting device, The fiber coil around which the single mode fiber was wound about many times, and the branching component which carries out light which came out of the light emitting device for 2 minutes, and is led to the ends of a fiber coil are included. Branch the light which came out of the light emitting device, and a fiber coil is made to spread to the circumference of a clock, and the circumference of an anti-clock. It asks for the luminous intensity which returned to the light source according to change of own operating state of a light emitting device, or the photocurrent of the photo detector for monitors. It is the optical fiber gyroscope which asked for the angular rate of rotation of a fiber coil from the phase contrast of the circumference light of a clock, and the circumference light of an anti-clock. The birefringence medium whose difference of the optical path length over an ordinary ray and an extraordinary ray is more than the coherence length of a light emitting device between a branching component and the light source The optical fiber gyroscope which takes out a signal from the light source characterized by preparing so that it may become in the direction in which about 45 degrees of main shafts inclined to the surroundings of the propagation direction to the polarization direction of the linearly polarized light, and making light which passes along a birefringence medium no polarizing.

[Claim 3] The light source containing the photo detector for monitors which is prepared the light emitting device which generates the homogeneous light or quasi-monochromatic light, and behind this, and supervises the luminescence reinforcement of a light emitting device, The fiber coil around which the single mode fiber was wound about many times, and the branching component which carries out light which came out of the light emitting device for 2 minutes, and is led to the ends of a fiber coil are included. Branch the light which came out of the light emitting device, and a fiber coil is made to spread to the circumference of a clock, and the circumference of an anti-clock. It asks for the luminous intensity which returned to the light source according to change of own operating state of a light emitting device, or the photocurrent of the photo detector for monitors. It is the optical fiber gyroscope which asked for the angular rate of rotation of a fiber coil from the phase contrast of the circumference light of a clock, and the circumference light of an anti-clock. A polarizer, The birefringence medium whose difference of the optical path length over an ordinary ray and an extraordinary ray is more than the coherence length of a light emitting device The anisotropy main shaft of a birefringence medium, and other main shafts, The optical fiber gyroscope which takes out a signal from the light source characterized by preparing between a branching component and the light source and making light which passes along a birefringence medium no polarizing so that it is made to become in the direction in which about 45 degrees of transparency shafts of a polarizer inclined to the surroundings of the propagation direction, and a polarizer may be on a light source side and a birefringence medium may be on a branching component side.

[Claim 4] The light source containing the photo detector for monitors which is prepared the light emitting device which generates the homogeneous light or quasi-monochromatic light, and behind this, and supervises the luminescence reinforcement of a light emitting device, The fiber coil around which the single mode fiber was wound about many times, and the branching component which carries out light which came out of the light emitting device for 2 minutes, and is led to the ends of a fiber coil are included. Branch the light which came out of the light emitting device, and a fiber coil is made to spread to the circumference of a clock, and the circumference of an anti-clock. It asks for the luminous intensity which returned to the light source according to change of own operating state of a light emitting device, or the photocurrent of the photo detector for monitors. The 1st birefringence medium by which it is the optical fiber gyroscope which asked for the angular rate of rotation of a fiber coil from the phase contrast of the circumference light of a clock, and the circumference light of an anti-clock, and the anisotropy main shaft leans to the about 45-degree propagation direction to the propagation direction of light, Make it be a right angle to the propagation direction of light, and an anisotropy main shaft and an isotropic main shaft the 2nd birefringence medium whose difference of the optical path length over an ordinary ray and an extraordinary ray is more than the coherence length of a light emitting device It prepares between the light source and a fiber. The optical fiber gyroscope which takes out a signal from the light source characterized by letting either the extraordinary ray separated spatially or an ordinary ray pass to the 2nd birefringence medium as the polarization direction accomplishes about 45 degrees to an anisotropy main shaft and an isotropic main shaft, and making light no polarizing by the 1st birefringence medium.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to amelioration of the optical fiber gyroscope which takes out a signal from the light source. The optical fiber gyroscope which takes out a signal from the light source excludes the photo detector of the dedication which receives return light, and it asks for a change of an interference light on the strength from property change of the light emitting device in the light source, and the output of the photo detector for monitors.
[0002]
[Description of the Prior Art] The usual optical fiber gyroscope makes the 1st coupler the linearly polarized light for the light which came out of the light source with through and a polarizer, carries out through light for the 2nd coupler for 2 minutes, makes a fiber coil spread this as a circumference light of the circumference **** clock of a clock, unites with the 2nd coupler, is put into reverse from the 1st coupler through a polarizer at a photo detector, and detects an interference light here. A light emitting device and a photo detector are prepared in the location of the symmetry at one side of the 1st coupler.
[0003] There are two couplers for making equal the path of the circumference light of a clock, and the circumference light of an anti-clock. Although the light to which the coupler branched, put light into the ends of a fiber coil, and came out of at least one fiber coil can be returned to a photo detector, since the paths of the circumference light of a clock and the circumference light of an anti-clock differ when it does so, offset comes out. Two couplers are required in order to solve this.
[0004] Moreover, if a polarizer is prepared in the middle of a coupler, polarization will gather in the circumference light of an anti-clock, and the circumference light of a clock. Thus, the optical fiber gyroscope containing elements, such as a light emitting device, a photo detector, a fiber coil, two couplers, and a polarizer, is minimum configuration. It was called and these have been made into an indispensable element.
[0005] However, this invention person recited ** in the common sense of an optical fiber gyroscope in this way. this invention person invented the optical fiber gyroscope which takes out a signal from the light source (Japanese Patent Application No. No. 57756 [five to]). Principle drawing is shown in drawing 2 .
[0006] The light source 1 generates the homogeneous light or quasi-monochromatic light. The light which came out of the light source 1 is extracted with a lens 10, and carries out incidence to the end face of a single mode fiber 2. This becomes the linearly polarized light through a polarizer 3, and branches in two light with a coupler (branching component) 4. Such light spreads the inside of the fiber coil 5 around which the single mode fiber was wound about many times as the circumference light of a clock, and a circumference light of an anti-clock. A phase modulator 6 is formed in an intermediate fiber, and a phase modulation is given to the light passing through this. A depolarizer 7 makes light passing through this no polarizing. This optical fiber gyroscope does not have the photo detector by which the number of couplers is one and they should be formed in the light source 1 and symmetrical relation.
[0007] The light which came out of the light source 1 branches to two with a coupler, and this returns to the light source 1 through a coupler the surroundings considering the fiber coil 5 as the circumference light of a clock, and a circumference light of an anti-clock. The light source 1 contains a light emitting device 8 and the photo detector 9 for monitors. The luminous intensity which returned to the light source 1 is detected by the operating current of light emitting device 8 self, or the photocurrent of the photo detector 9 for monitors. The synchronous detection of this is carried out by the carrier signal of a phase modulator, and the angular rate of rotation is called for.
[0008] Such an optical fiber gyroscope of a configuration is aforementioned minimum configuration. It is made with still fewer components. Since there are few one difficult couplers of manufacture, effectiveness is in cost reduction. Moreover, there is also an advantage that a photo detector can be reduced.
[0009] In this optical fiber gyroscope, a fiber coil may be manufactured by the mere single mode fiber (SM), or you may manufacture with polarization maintaining optical fiber (PM). Since plane of polarization is always saved when making from polarization maintaining optical fiber, it is convenient. The depolarizer 7 is unnecessary.

However, this is an expensive fiber. This pushes up the cost of an optical fiber gyroscope.
[0010] A device is required, although it becomes a low price more when a fiber coil is made from a single mode fiber. A single mode fiber does not have the function to hold plane of polarization. If it remains as it is, a scale factor is changed for rotatory polarization, or a drift occurs. Then, it is necessary to put in a depolarizer 7 and to make it no polarizing. A reason is explained briefly.
[0011] Since a single mode fiber is completely axial symmetry, it does not have polarization maintenance capacity. After light turns into the linearly polarized light with a polarizer 3, it passes along the fiber coil 5. Since a single mode fiber does not save a polarization condition, a polarization revolution may be carried out on the way. When the linearly polarized light tends to pass along a polarizer from a fiber coil in a sake at the reverse sense, this cannot necessarily pass a polarizer. Then, after putting in a depolarizer and making it no polarizing, he is trying to return to a polarizer. If it carries out like this, the power of the one half of light can penetrate a polarizer. Thereby, fluctuation of a scale factor can be controlled.
[0012] There is one more function of a depolarizer. An optical-path-length difference is between the cross polarization when spreading a fiber coil. Since this causes a drift, the polarizer has prescribed the polarization direction to one. The extinction ratio of a polarizer is a multiplier showing the capacity which makes light the linearly polarized light. The amount of transparency of the right-angled linearly polarized light is divided into a transparency shaft by the amount of transparency of the linearly polarized light parallel to a transparency shaft. If this ratio is 0, it is perfect as a polarizer. However, in a actual polarizer, this is limited.
[0013] If the light of all polarization conditions has coherence, the extinction ratio required of a polarizer will become very small. A fabrication is difficult for this. He is trying not to interfere in a depolarizer by giving the difference of the optical path length more than coherence length between cross polarization. This has mitigated the burden of a polarizer reversely. That is, the depolarizer is also carrying out the operation which complements an operation of a polarizer and prevents a drift.
[0014] As a depolarizer, the depolarizer of Lyot is known well. This leans the main shaft of the crystal of two birefringence 45 degrees, and makes it rival. A bulk crystal is used and also a depolarizer can be made using polarization maintaining optical fiber (birefringence fiber). As shown in drawing 3 , after 45 degrees of mutual main shafts have inclined, fusion splicing of the two polarization maintaining optical fiber (PM) is carried out. This becomes a depolarizer.
[0015] A few is explained about a depolarizer. There is a birefringence body and it is no about ne and an ordinary index in the extraordinary-ray refractive index of this. It carries out. Die length is set to L. Then, difference deltaL of the optical path length of the extraordinary ray when penetrating this body and an ordinary ray applies L to the difference of a refractive index. It is made longer [this] than the coherence length Lc of light.
[0016]
deltaL=|(ne-no) |L>Lc (1)
[0017] Distance detached building **** longer than coherence length does not interfere. Then, the extraordinary ray and ordinary ray which passed along this birefringence body do not interfere. A depolarizer contains two birefringence bodies with which are satisfied of such conditions. The ratio of die length is set to 1:2 in many cases. The 2nd birefringence body is made to rival so that a main shaft may accomplish 45 degrees on the 1st birefringence body. Then, when going into the 2nd body, an ordinary ray and an extraordinary ray are divided in the direction of a main shaft at by [one half] power. These spread as an extraordinary ray and an ordinary ray. The power of the light of the plane of polarization which intersects perpendicularly immediately after coming out of the 2nd birefringence body is equal. It has the power also with the same light which has plane of polarization in which direction as a sake.
[0018] Moreover, the four different optical path lengths occur by the birefringence. If the light of the lump simultaneously generated in the light source will be expressed as a wave packet, after passing the first birefringence body, it will become two wave packets. After passing two more birefringence bodies, four different wave packets exist. When the ratio of the die length of a birefringence body is set to 1:2, the distance between four wave packets is equal. And it is separated from each of these more than coherence length. These four wave packets do not interfere in a sake. The reinforcement of the linearly polarized light of which direction is also equal, and since interference does not take place between cross polarization, this can say no polarizing. It is close to it even if it is not no perfect polarizing like an incandescent lamp. Then, 45 degrees of two birefringence bodies with which are satisfied of (1) were twisted, and they were made to rival in a depolarizer.
[0019]
[Problem(s) to be Solved by the Invention] It is difficult to carry out fusion splicing of the two polarization maintaining optical fiber, where 45 degrees of the main shaft are twisted. The fusion splicing machine of dedication is required. There must not be no gap of the include angle from 45 degrees. it is necessary to boil

manufacture conditions markedly and to manage them severely compared with the fusion splicing of the usual single mode fiber Compared with the polarization-maintaining-optical-fiber [itself] single mode fiber, it is an expensive frame. Existence of the depolarizer which carries out 2 fusion splicing of the polarization maintaining optical fiber by such reason makes an optical fiber gyroscope the thing of high cost.
[0020] The optical fiber gyroscope which takes out a signal from the light source is this invention person's original structure. However, there was a difficulty of becoming still more expensive for a depolarizer. Existence of a depolarizer bars mass production nature and has been the failure of a cost cut. It is the object of this invention to conquer such a difficulty, and for it to be more rich in mass production nature, and to offer a cheaper optical fiber gyroscope.
[0021]
[Means for Solving the Problem] The optical fiber gyroscope of this invention places one birefringence body between the light source and a fiber edge. Thereby, an operation equivalent to a depolarizer is made to perform. Two birefringence bodies are not required. It is not necessary to make these rival. One birefringence body is only used. As a birefringence medium, a rutile crystal, a calcite crystal, polarization maintaining optical fiber, etc. can be used. Three cases are divided roughly by the polarization condition of the light source, or the existence of a polarizer.
[0022] ** When the light from the light source does not polarize, the direction of a birefringence medium is arbitrary.
** When the light from the light source is the linearly polarized light, the main shaft of a birefringence medium accomplishes the linearly polarized light and 45 degrees.
** When preparing a polarizer between the light source and a fiber edge, the main shaft of a birefringence medium accomplishes the include angle of 45 degrees around the transparency shaft of a polarizer, and the propagation direction, and, moreover, forms a birefringence medium between a polarizer and a fiber edge.
[0023] Drawing 1 is the theoretic block diagram of the optical fiber gyroscope of this invention. The birefringence medium 11 is placed between the lens and the fiber edge. It is condensed with a lens, and the homogeneous light or quasi-monochromatic light which came out of the light source 1 passes along the birefringence medium 11, and carries out incidence to the edge of a fiber 2. This separates in two light with the branching component 4, and spreads the fiber coil 5 to the circumference of a clock, and the circumference of an anti-clock. It coalesces with the branching component 4, and this comes out from a fiber edge, passes along the birefringence medium 11, and returns to the light source 1. This signal contains the circumference light of an anti-clock the circumference of the clock of the phase contrast proportional to the angular rate of rotation of a fiber coil. The synchronous detection of the photocurrent of the photo detector for current change and the monitors of a light emitting device is carried out, and it asks for the angular rate of rotation. Upper ** and upper ** correspond to this configuration.
[0024] Drawing 4 shows other examples of this invention. This places a polarizer 20 and the birefringence medium 11 between the light source and a fiber edge. To the transparency shaft of a polarizer, it installs so that the main shaft of a birefringence medium may accomplish the include angle of 45 degrees. Upper ** corresponds to this configuration.
[0025]
[Function] An operation of the birefringence medium of this invention has a peculiar thing. Next, an operation of the birefringence medium in the optical fiber gyroscope of this invention is explained. A birefringence medium is shown in drawing 5 . A birefringence medium has the case of 1 shaft anisotropy and a biaxial anisotropy. This invention can apply either. In the case of a biaxial anisotropy, since three main shafts which intersect perpendicularly are distinguishable, it is satisfactory.
[0026] Since there is an equivalent shaft in the case of 1 shaft anisotropy, explanation is required for a while. If an optical main shaft is made into an a-axis, a b-axis, and c axis in the case of 1 shaft anisotropy, generally an a-axis and a b-axis will be equivalent, and c axis will turn into an anisotropy shaft. In this case, when an extraordinary ray and an ordinary ray do not tend to be separated spatially but it is going to give the optical path length's difference by the birefringence, it is made for ac side to become the propagation direction and right angle of light. That is, a b-axis is parallel to the propagation direction. And it is made in agreement [the X-axis and a Y-axis] with the optical main shaft (an a-axis, c axis). Let the travelling direction of light be a Z direction (for it to be parallel to a b-axis).
[0027] In the case of a biaxial anisotropy, although which optical main shaft (an a-axis, a b-axis, c axis) is chosen as a Z direction, it does not interfere. The linearly polarized light which polarized in the direction of X is made Y polarization in the linearly polarized light which polarized in X polarization and the direction of Y. When X polarization and Y polarization carry out incidence, phase velocity changes with the birefringence operations. When it passes through a medium, difference deltaL of the optical path length proportional to a refractive-index

difference occurs. It is ny about the refractive index of nx and Y polarization in the refractive index of X polarization. Carrying out, optical-path-length difference deltaL is [0028].
deltaL=|nx-ny |L (2)
[0029] It is expressed be alike. This considers as a thing longer than the coherence length Lc of the light source.
[0030]
deltaL>Lc (3)
[0031] If it carries out like this, it will not interfere in X polarization and Y polarization henceforth. A depolarizer is what made reinforcement of X polarization and Y polarization equal here. In order to make this equal, conventionally, the birefringence medium by which another 45-degree main shaft inclined to the preceding paragraph was placed, and reinforcement of X polarization and Y polarization was made the same by this. The 1st medium of the conventional depolarizer is for making equivalent X and Y polarization. If there are some which otherwise make equivalent X and Y polarization, it can consider as a depolarizer effectually by one birefringence medium.
[0032] Generally the low light source of coherence with short coherence length, such as a super luminescent diode, is used for an optical fiber gyroscope. A super luminescent diode emits light in the middle condition of luminescence by the same spontaneous emmision as LED, and luminescence by the induced emission of a laser diode. That is, luminescence of a super luminescent diode is the combination in the luminescence mode of spontaneous emmision and induced emission. Both ratio changes with actuation currents. Generally, when luminescence power is low, spontaneous emmision is main, and induced emission becomes large when luminescence power is high. Above ** and ** are distinguished according to a luminescence condition.
[0033] ** When the light source emitted light by spontaneous emmision, this light did not polarize. When driving a super luminescent diode by low power, it becomes luminescence almost near no polarizing. In this case, bearing of the main shaft of a birefringence medium may be the direction of arbitration (in a field vertical to an optical axis). Although it is close to no polarizing from the first, X polarization and Y polarization are pulled apart more than coherence length, and since it prevents from interfering mutually, it is no polarizing more nearly thoroughly. X and Y polarization are here unrelated to the polarization condition of the light source at the thing to say of having polarization in the direction of the main shaft of a birefringence medium.
[0034] ** When the light source mainly emits light by induced emission, this becomes the linearly polarized light. The direction of polarization is decided by crystallographic bearing of a component. In this case, the polarization direction of the linearly polarized light and the direction of the main shaft of a birefringence medium accomplish 45 degrees. Since the direction of the linearly polarized light is carried out in the XY direction, power equal to X polarization and Y polarization which are polarization parallel to the main shaft of a birefringence medium is distributed. Since such light separates through a medium more than coherence length, it does not interfere after this. Moreover, since luminous intensity with polarization of the direction of arbitration becomes equal, it is no polarizing.
[0035] ** Even if there is no polarizer, the optical fiber gyroscope of this invention can achieve the function. However, what is necessary is just to form a polarizer 20 in the light source side (drawing 4) of a birefringence medium, in order to improve polarization selectivity further. In this case, the main shaft of a birefringence medium sets up so that the transparency shaft of a polarizer and 45 degrees may be accomplished. That is, when the crystal main shaft a-axis and c axis of a birefringence medium are taken to the X-axis and Y shaft orientations, the linearly polarized light has polarization in the XY direction. ** The same power as X polarization and Y polarization is distributed similarly. These are distance detached building ******** more than the coherence length of the light source. It is between rectangular polarization and interference did not take place, and since the luminous intensity of cross polarization was equal, it did not polarize. The birefringence medium set as usual special bearing instead of a polarizer can also be used as a polarizer.
[0036] ** ** uses that other components form the linearly polarized light, and demonstrates the same function as a depolarizer by one birefringence medium.
[0037]
[Example] With the configuration of drawing 1 , the optical crystal of bulk is used as a birefringence medium, for example. A rutile crystal, a calcite, Xtal, etc. can be used. Here, the calcite was used as a birefringence medium. It is ordinary-index ne =1.66 and extraordinary-ray refractive-index no =1.49. Since a refractive-index difference is 0.17, optical-path-length difference deltaL is [0038].
deltaL=0.17L (4)
[0039] It becomes. Suppose that SUPARUMINESSENTO was used as the light source. Coherence length Lc adopts what is 50 micrometers as a typical example. Then, it is [0040] in order to give an optical-path-length difference longer than coherence length.

0.17L> 50 micrometers (5)
[0041] It comes out. Then, die-length L of a calcite L> 294 micrometers (6)
[0042] What is necessary is just to come out. It turns out as a very thin calcite crystal that it is good. When the coherence length of the light source is longer, according to it, it is necessary to lengthen a crystal. (1) It is easily calculable with a formula.
[0043] Polarization maintaining optical fiber can also be used as a birefringence medium. Rate B=nx-ny of a birefringence Since it understands, the die length of a required fiber is calculable. For example, the birefringence B of standard polarization maintaining optical fiber is 5x10-4. In this case, [0044]
0.0005L> 50 micrometers (7)
L>100mm (8)
[0045] It becomes. That is, it is if it is this polarization maintaining optical fiber. About 0.1m is sufficient. It is fully short and does not become cost high. If it is going to make the usual depolarizer, one more polarization maintaining optical fiber twice the die length of this is needed, and fusion splicing must be carried out to a precision so that the include angle whose direction of an anisotropy is 45 degrees about these may be accomplished. A fiber can be managed with one by this invention and precise fusion splicing is also unnecessary (however, the connection with a single mode fiber 2 is required).
[0046] Like drawing 4 , when forming a polarizer 20 before a birefringence medium or in the back, the transparency shaft of a polarizer and 45 degrees of main shafts of a birefringence medium are leaned. A metal dielectric multilayer is [whose polarizer is] like a polarizing prism sufficient as it. Or a fiber mold polarizer can also be used.
[0047] Or another birefringence medium 21 which leaned the anisotropy shaft (c axis) in the direction of 45 degrees of front like drawing 6 may be used. The next birefringence medium 11 is a birefringence medium which is carrying out main work by this invention. If the travelling direction of light is made into a Z direction (Z=b), the anisotropy shaft of the birefringence medium 11 is parallel to the X-axis or a Y-axis (X=a, Y=c or X=c, Y=a). However, the front birefringence medium 21 is for taking out only the linearly polarized light like [while] a polarizer. Since an ordinary ray (continuous line) is right-angle incidence, it goes straight on as it is. A path is refracted by only the part of a birefringence although an extraordinary ray (broken line) is right-angle incidence.

[0048] This is a phenomenon which happens notably especially, when 45 degrees (c axis) of anisotropy shafts of a birefringence medium lean to the travelling direction (Z direction) of light. The direction of ****** (an a-axis, b-axis) is arbitrary. The include angle theta of the gap from the right angle of an extraordinary ray becomes the value which broke the difference of a refractive index by the average of a birefringence, when c axis accomplishes the include angle of 45 degrees to a Z direction. theta=2(ne-no)/(ne+no). If a birefringence medium has sufficient thickness, the extraordinary ray which has separated from the optical axis will not go into an optical fiber.
[0049] I hear that polarization does not have a c axis component, and an ordinary ray can be defined here. It is the linearly polarized light which has polarization in the direction of the difference of an a-axis unit vector and a b-axis unit vector. The direction of the linearly polarized light is decided. It defines by saying that an extraordinary ray has a polarization component also in c shaft orientations, and has the polarization which intersects perpendicularly with polarization of the propagation direction and an ordinary ray. Only an ordinary ray goes into an optical fiber through the birefringence medium 11 henceforth. That is, an ordinary ray and an extraordinary ray are separated spatially. For this reason, the first birefringence medium 21 has an operation equivalent to a polarizer. It is also possible to drive out only an extraordinary ray to through and to drive out an ordinary ray besides a fiber reversely, at a fiber. Any are sufficient. This is explained to Japanese Patent Application No. No. 208683 [five to] "a polarization selection component, a light source module, and an optical fiber gyroscope" which becomes this invention person's proposal in detail.
[0050] The 2nd birefringence medium is installed in the same direction as what has so far been explained to this. A b-axis turns to a Z direction. An a-axis and c axis are right-angled to a Z direction. To the linearly polarized light (the direction of the difference of a vector of the 1st birefringence medium, and b vector) which came out of the 1st birefringence medium, it installs so that an a-axis and c axis may accomplish the include angle of 45 degrees.
[0051]
[Effect of the Invention] In the "optical fiber gyroscope which takes out a signal from the light source" (Japanese Patent Application No. No. 57756 [five to]) which this invention person proposed previously, when the fiber coil was made into the single mode fiber, the depolarizer was required. This invention can change light into no polarizing like a depolarizer only by forming one birefringence medium between the light source and a fiber. A complicated, unstable, and difficult process [say / carrying out fusion splicing of the

expensive polarization maintaining optical fiber so that 2 and an anisotropy shaft may accomplish 45 degrees] can be skipped. Thereby, the optical fiber gyroscope of low cost can be manufactured.

[Translation done.]

* NOTICES *

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The principle block diagram of the optical fiber gyroscope which takes out a signal from the light source of this invention.
[Drawing 2] Principle drawing of the optical fiber gyroscope (Japanese Patent Application No. No. 57756 [five to]) which this invention person invented previously.
[Drawing 3] The schematic diagram of the depolarizer concerning the conventional example which carries out fusion splicing of the two polarization maintaining optical fiber so that 45 degrees of anisotropy shafts may differ, and uses it as a depolarizer.
[Drawing 4] Outline principle drawing showing other configurations of the optical fiber gyroscope of this invention.
[Drawing 5] Drawing for explaining an operation of a birefringence medium in this invention.
[Drawing 6] The outline block diagram showing the example using the birefringence medium as a thing equivalent to a polarizer.
[Description of Notations]
1 Light Source
2 Single Mode Fiber
3 Polarizer
4 Branching Component
5 Fiber Coil
6 Phase Modulator
7 Depolarizer
8 Light Emitting Device
9 Photo Detector for Monitors
10 Lens
11 Birefringence Medium
20 Polarizer
21 Birefringence Medium

[Translation done.]

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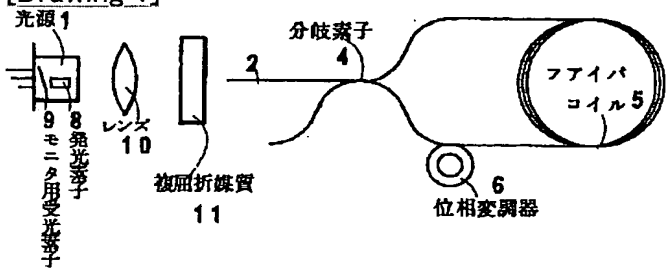
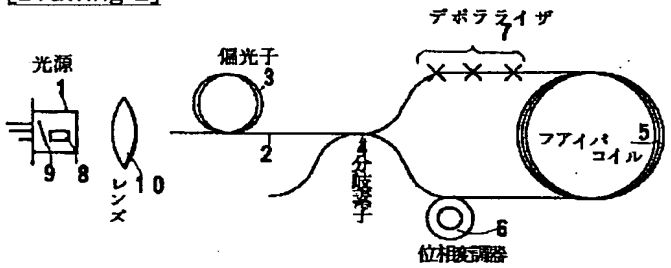
DRAWINGS

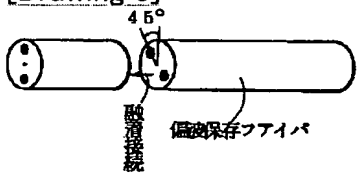
[Drawing 1]



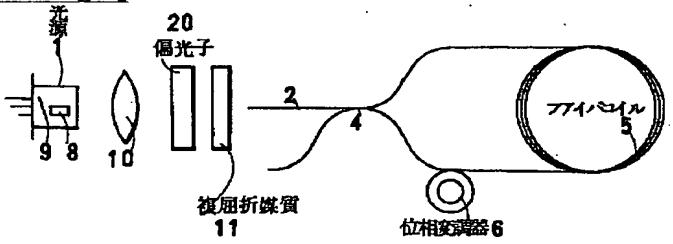
[Drawing 2]



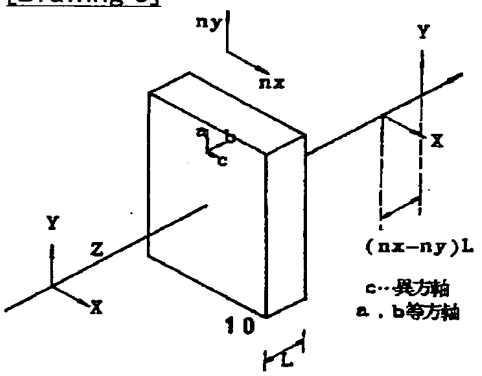
[Drawing 3]



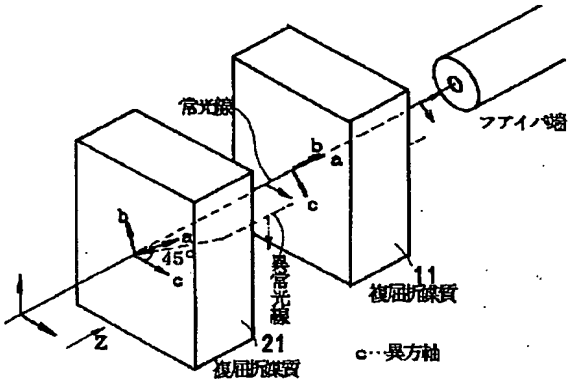
[Drawing 4]



[Drawing 5]



[Drawing 6]



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	3/083					
			6920－2Ｋ	Ｇ０２Ｂ	6/ 00	Ｂ

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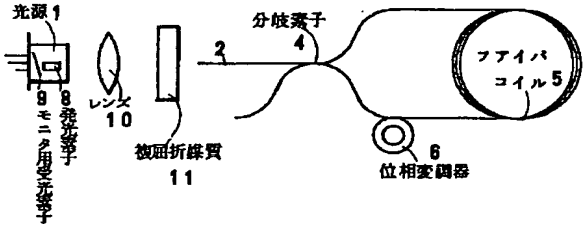
(54)【発明の名称】　光源から信号を取り出す光ファイバジャイロ

(57)【要約】

【目的】　光源から出てファイバコイルを時計廻り、反時計廻りに伝搬した光を光源に戻し、発光素子の電流、電圧変化、モニタ用の受光素子の光電流から角速度を求めるようにした光ファイバジャイロにおいて、デポラライザの構造をより簡略にすること。

【構成】　常光線と異常光線に対する光路長の差が光源のコヒーレンス長以上である複屈折媒質を、ファイバ端と光源の間に設ける。光源が無偏光の光を出す場合は、複屈折媒質の方位は任意である。光源が直線偏光を出す場合は複屈折媒質の主軸が直線偏光に対して４５度の角度を成すようにする。偏光子を設ける場合は、複屈折媒質の主軸が偏光子の透過軸に対して４５度の角度を成すように設置する。



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【特許請求の範囲】

【請求項１】　単色光又は準単色光を発生する発光素子とこれの背後に設けられ発光素子の発光強度を監視するモニタ用の受光素子を含む光源と、シングルモードファイバを多数回巻き回したファイバコイルと、発光素子から出た光を２分してファイバコイルの両端に導く分岐素子とを含み、発光素子から出た光を分岐しファイバコイルを時計廻り、反時計廻りに伝搬させ、光源に戻った光の強度を、発光素子自身の動作状態の変化あるいはモニタ用の受光素子の光電流によって求め、時計廻り光と反時計廻り光の位相差からファイバコイルの回転角速度を求めるようにした光ファイバジャイロであって、常光線と異常光線に対する光路長の差が発光素子のコヒーレンス長以上である複屈折媒質を、分岐素子と光源の間に設けて、複屈折媒質を通る光を無偏光にすることを特徴とする光源から信号を取り出す光ファイバジャイロ。

【請求項２】　直線偏光の単色光又は準単色光を発生する発光素子とこれの背後に設けられ発光素子の発光強度を監視するモニタ用の受光素子を含む光源と、シングルモードファイバを多数回巻き回したファイバコイルと、発光素子から出た光を２分してファイバコイルの両端に導く分岐素子とを含み、発光素子から出た光を分岐しファイバコイルを時計廻り、反時計廻りに伝搬させ、光源に戻った光の強度を、発光素子自身の動作状態の変化あるいはモニタ用の受光素子の光電流によって求め、時計廻り光と反時計廻り光の位相差からファイバコイルの回転角速度を求めるようにした光ファイバジャイロであって、常光線と異常光線に対する光路長の差が発光素子のコヒーレンス長以上である複屈折媒質を、分岐素子と光源の間に、直線偏光の偏光方向に対して主軸が伝搬方向の回りに約４５°傾いた方向になるように設けて、複屈折媒質を通る光を無偏光にすることを特徴とする光源から信号を取り出す光ファイバジャイロ。

【請求項３】　単色光又は準単色光を発生する発光素子とこれの背後に設けられ発光素子の発光強度を監視するモニタ用の受光素子を含む光源と、シングルモードファイバを多数回巻き回したファイバコイルと、発光素子から出た光を２分してファイバコイルの両端に導く分岐素子とを含み、発光素子から出た光を分岐しファイバコイルを時計廻り、反時計廻りに伝搬させ、光源に戻った光の強度を、発光素子自身の動作状態の変化あるいはモニタ用の受光素子の光電流によって求め、時計廻り光と反時計廻り光の位相差からファイバコイルの回転角速度を求めるようにした光ファイバジャイロであって、偏光子と、常光線と異常光線に対する光路長の差が発光素子のコヒーレンス長以上である複屈折媒質とを、複屈折媒質の異方性主軸と他の主軸と、偏光子の透過軸とが伝搬方向の周りに約４５°傾いた方向になるようにし、偏光子が光源側に複屈折媒質が分岐素子側になるように、分岐素子と光源の間に設けて、複屈折媒質を通る光を無偏光にすることを特徴とする光源から信号を取り出す光ファイバジャイロ。

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【請求項４】　単色光又は準単色光を発生する発光素子とこれの背後に設けられ発光素子の発光強度を監視するモニタ用の受光素子を含む光源と、シングルモードファイバを多数回巻き回したファイバコイルと、発光素子から出た光を２分してファイバコイルの両端に導く分岐素子とを含み、発光素子から出た光を分岐しファイバコイルを時計廻り、反時計廻りに伝搬させ、光源に戻った光の強度を、発光素子自身の動作状態の変化あるいはモニタ用の受光素子の光電流によって求め、時計廻り光と反時計廻り光の位相差からファイバコイルの回転角速度を求めるようにした光ファイバジャイロであって、異方性主軸が光の伝搬方向に対して約４５°伝搬方向に対して傾いている第１の複屈折媒質と、異方性主軸と等方性主軸が光の伝搬方向に対して直角になるようにしてあり常光線と異常光線に対する光路長の差が発光素子のコヒーレンス長以上である第２の複屈折媒質とを、光源とファイバの間に設けて、第１の複屈折媒質によって空間的に分離された異常光線または常光線のいずれかのみを偏光方向が異方性主軸と等方性主軸に対して約４５°を成すようにして第２の複屈折媒質に通して光を無偏光にすることを特徴とする光源から信号を取り出す光ファイバジャイロ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は光源から信号を取り出す光ファイバジャイロの改良に関する。光源から信号を取り出す光ファイバジャイロというのは、戻り光を受光する専用の受光素子を省き、光源にある発光素子の特性変化か、モニタ用の受光素子の出力から干渉光の強度変化を求めるものである。

【０００２】

【従来の技術】通常の光ファイバジャイロは光源から出た光を第１カップラを通し、偏光子で直線偏光にして、第２カップラを通し光を２分しこれをファイバコイルに時計廻り光反時計廻り光として伝搬させて第２カップラで合一し偏光子を逆に通して第１カップラから受光素子に入れここで干渉光を検出するようになっている。発光素子と受光素子が第１カップラの一方に対称の位置に設けられる。

【０００３】カップラが二つあるのは時計廻り光と反時計廻り光の経路を等しくするためである。カップラがひとつでも、光を分岐しファイバコイルの両端に入れ、ファイバコイルから出た光を受光素子に戻すことはできるが、そうすると時計廻り光と反時計廻り光の経路が異なるのでオフセットが出る。これを解決するためにカップラは二つ必要である。

【０００４】またカップラの途中に偏光子を設けると反時計廻り光、時計廻り光において偏光が揃う。このよう

に発光素子、受光素子、ファイバコイル、二つのカップラ、偏光子などの要素を含む光ファイバジャイロがminimum configuration と呼ばれ、これらは不可欠の要素とされてきた。

【０００５】しかし本発明者はこのように光ファイバジャイロの常識に異を唱えた。本発明者は、光源から信号を取り出す光ファイバジャイロを発明した（特願平５－５７７５６号）。図２に原理図を示す。

【０００６】光源１は単色光または準単色光を発生する。光源１から出た光はレンズ１０で絞られてシングルモードファイバ２の端面に入射する。これが偏光子３を通り直線偏光になって、カップラ（分岐素子）４で二つの光に分岐する。これらの光がシングルモードファイバを多数回巻き回したファイバコイル５の中を時計廻り光、反時計廻り光として伝搬する。位相変調器６が途中のファイバに設けられて、ここを通る光に位相変調を与える。デポラライザ７がここを通る光を無偏光にする。この光ファイバジャイロはカップラがひとつで、光源１と対称の関係に設けられるべき受光素子を持たない。

【０００７】光源１から出た光はカップラで２つに分岐しこれが、ファイバコイル５を時計廻り光、反時計廻り光として回り、カップラを通り光源１に戻る。光源１は発光素子８とモニタ用受光素子９を含む。光源１に戻った光の強度は、発光素子８自身の動作電流、またはモニタ用受光素子９の光電流によって検出される。これが位相変調器のキャリヤ信号により同期検波され回転角速度が求められる。

【０００８】このような構成の光ファイバジャイロは、前記のminimum configuration よりもさらに少ない部品によって作られる。製造の難しいカップラがひとつ少ないのでコスト削減に効果がある。また受光素子を減らすことができるという利点もある。

【０００９】この光ファイバジャイロにおいては、ファイバコイルを単なるシングルモードファイバ（ＳＭ）で製作しても、偏波保持光ファイバ（ＰＭ）で製作しても良い。偏波保持光ファイバで作る場合は偏波面が常に保存されるので好都合である。デポラライザ７は不要である。しかしこれは高価なファイバである。これが光ファイバジャイロのコストを押し上げる。

【００１０】シングルモードファイバでファイバコイルを作った場合はより低価額になるが、工夫がいる。シングルモードファイバは偏光面を保持する機能がない。そのままでは、偏光面の回転のためにスケールファクタが変動したりドリフトが発生したりする。そこでデポラライザ７を入れて無偏光にする必要がある。理由を簡単に説明する。

【００１１】シングルモードファイバは完全に軸対称であるため、偏波保持能力がない。光が偏光子３で直線偏光になってからファイバコイル５を通る。シングルモードファイバは偏光状態を保存しないので、途中で偏波回転する可能性がある。ために直線偏光がファイバコイルから反対向きに偏光子を通ろうとするときに、これが偏光子を通過できるとは限らない。そこでデポラライザを入れ無偏光にしてから偏光子に返すようにしている。こうすると光の半分のパワーが偏光子を透過できる。これによりスケールファクターの変動を抑制できる。

【００１２】デポラライザの機能はもうひとつある。ファイバコイルを伝搬する時の直交偏波間に光路長差がある。これがドリフトの原因になるので、偏光子により偏光方向をひとつに規定している。偏光子の消光比は、光を直線偏光にする能力を表す係数である。透過軸に平行な直線偏光の透過量で、透過軸に直角な直線偏光の透過量を割ったものである。この比が０であれば偏光子として完全である。しかし実際の偏光子ではこれは有限である。

【００１３】もしも全ての偏光状態の光が干渉性を持つとすれば、偏光子に要求される消光比は極めて小さいものになる。これは製作が難しい。デポラライザは直交偏波間でコヒーレンス長以上の光路長の差を与えることにより干渉しないようにしている。これは反対に偏光子の負担を軽減している。つまりデポラライザは、偏光子の作用を補完しドリフトを防ぐ作用もしている。

【００１４】デポラライザとしてはＬｙｏｔのデポラライザが良く知られている。これは二つの複屈折性の結晶の主軸を４５度傾けて張り合わせたものである。バルク結晶を使う他に偏波保持光ファイバ（複屈折ファイバ）を使ってデポラライザを作ることができる。図３に示すように、２本の偏波保持光ファイバ（ＰＭ）を互いの主軸が４５°傾いた状態で融着接続する。これによりデポラライザとなる。

【００１５】デポラライザについて少し説明する。複屈折性物体がありこれの異常光線屈折率をｎ。、常光線屈折率をｎ。とする。長さをＬとする。するとこの物体を透過した時の、異常光線、常光線の光路長の差ΔＬは屈折率の差にＬをかけたものである。これが光のコヒーレンス長Ｌｃより長いようにする。

【００１６】

$$\Delta L = |(n_{。} - n_{。})| L > Lc \qquad (1)$$

【００１７】コヒーレンス長より長い距離離れた光は干渉しない。そこでこの複屈折物体を通った異常光線、常光線が干渉しない。デポラライザはこのような条件を満足する二つの複屈折物体を含む。長さの比は１：２にすることが多い。第１複屈折物体に主軸が４５°を成すように第２の複屈折物体を張り合わせる。すると第２の物体に入るときに常光線、異常光線ともに主軸方向に半分ずつのパワーに分割される。これらが異常光線、常光線として伝搬する。第２の複屈折物体を出た直後において、直交する偏波面の光のパワーが等しい。ためにどの

方向に偏波面を持つ光も同じパワーを有する。

【００１８】また複屈折により４つの異なる光路長が発生する。もしも光源で同時に発生した一塊の光を波束と表現することにすれば、はじめの複屈折物体を通過した後、２つの波束になる。さらに二つの複屈折物体を通過した後では、４つの異なる波束が存在する。複屈折物体の長さの比を１：２にすると、４つの波束間の距離は等しい。しかもこれらはいずれもコヒーレンス長以上離れている。ためにこれらの４つの波束が干渉しない。どの方向の直線偏光の強度も等しく、直交偏波間で干渉が起こらないのでこれが無偏光ということができる。白熱電球のような完全な無偏光ではないにしてもそれに近いものである。そこで、（１）を満足する二つの複屈折物体を４５°捻じって張り合わせたものがデポラライザになる。

【００１９】

【発明が解決しようとする課題】２本の偏波保持光ファイバを、その主軸が４５°捻れた状態で融着接続するのは難しい。専用の融着接続機が必要である。４５°からの角度のずれがあってはならない。通常のシングルモードファイバの融着接続に比べて製造条件を格段に厳しく管理する必要がある。偏波保持光ファイバ自体シングルモードファイバに比べて高価額である。このような理由で偏波保持光ファイバを２本融着接続するデポラライザの存在は光ファイバジャイロを高コストのものにする。

【００２０】光源から信号を取り出す光ファイバジャイロは本発明者独自の構造である。しかしデポラライザのためになお高価なものになるという難点があった。デポラライザの存在が量産性を妨げ、コストダウンの障害となっている。このような難点を克服しより量産性に富みより安価な光ファイバジャイロを提供することが本発明の目的である。

【００２１】

【課題を解決するための手段】本発明の光ファイバジャイロは、光源とファイバ端の間にひとつの複屈折物体を置く。これによりデポラライザと等価な作用を行なわせる。二つの複屈折物体を要しない。これらを張り合わせる必要もない。ひとつの複屈折物体を使うだけである。複屈折媒質としては、ルチル結晶、方解石結晶、偏波保持光ファイバなどを用いることができる。光源の偏光状態により、あるいは偏光子の有無により３つの場合が大別される。

【００２２】①光源からの光が無偏光の場合、複屈折媒質の方向は任意である。

②光源からの光が直線偏光の場合、複屈折媒質の主軸が直線偏光と４５°を成すようにする。

＊

$$\Delta L = |n_x - n_y| L \qquad (2)$$

【００２９】によって表される。これが光源のコヒーレンス長Ｌｃより長いものとする。

※

$$\Delta L > Lc \qquad (3)$$

＊③光源とファイバ端の間に偏光子を設ける場合、複屈折媒質の主軸が、偏光子の透過軸と伝搬方向の周りに４５度の角度を成し、しかも偏光子とファイバ端の間に複屈折媒質を設ける。

【００２３】図１は本発明の光ファイバジャイロの原理的な構成図である。レンズとファイバ端の間に複屈折媒質１１を置いている。光源１から出た単色光または準単色光がレンズで集光され、複屈折媒質１１を通り、ファイバ２の端部に入射する。これが分岐素子４で二つの光に別れてファイバコイル５を時計廻り、反時計廻りに伝搬する。これが分岐素子４で合体し、ファイバ端から出て複屈折媒質１１を通り、光源１に戻る。この信号はファイバコイルの回転角速度に比例する位相差の時計廻り、反時計廻り光を含む。発光素子の電流変化やモニタ用の受光素子の光電流を同期検波して回転角速度を求める。上の①と②はこの構成に対応する。

【００２４】図４は本発明の他の例を示す。これは光源とファイバ端の間に偏光子２０と、複屈折媒質１１を置いたものである。偏光子の透過軸に対して、複屈折媒質の主軸が４５度の角度を成すように設置する。上の③はこの構成に対応する。

【００２５】

【作用】本発明の複屈折媒質の作用は独特なものがある。次に本発明の光ファイバジャイロにおける複屈折媒質の作用について説明する。図５に複屈折媒質を示す。複屈折媒質は１軸異方性、２軸異方性の場合がある。本発明はいずれでも適用できる。２軸異方性の場合は３つの直交する主軸が区別できるので問題がない。

【００２６】１軸異方性の場合は、等価な軸があるので少し説明を要する。１軸異方性の場合、光学主軸をａ軸、ｂ軸、ｃ軸とすると、一般にａ軸とｂ軸が等価で、ｃ軸が異方性軸になる。この場合、異常光線と常光線を空間的に分離せず、複屈折により光路長の差を与えようとすると、ａｃ面が光の伝搬方向と直角になるようにする。つまりｂ軸が伝搬方向に平行である。そして、Ｘ軸、Ｙ軸が光学主軸（ａ軸、ｃ軸）に一致するようにしてある。光の進行方向をＺ方向（ｂ軸に平行）とする。

【００２７】２軸異方性の場合は、どの光学主軸（ａ軸、ｂ軸、ｃ軸）をＺ方向に選んでも差し支えない。Ｘ方向に偏光した直線偏光をＸ偏波、Ｙ方向に偏光した直線偏光をＹ偏波ということにする。Ｘ偏波とＹ偏波が入射した場合、その複屈折作用により位相速度が異なる。媒質を通り抜けた時に屈折率差に比例する光路長の差ΔＬが発生する。Ｘ偏波の屈折率をn_x、Ｙ偏波の屈折率をn_yとして、光路長差ΔＬは

【００２８】

※【００３０】

【００３１】こうすると、Ｘ偏波とＹ偏波は以後干渉することがない。デポラライザというのはここでＸ偏波とＹ偏波の強度を等しくしたものなのである。これを等しくするために、従来は前段にもうひとつの４５度主軸の傾いた複屈折媒質を置き、これによって、Ｘ偏波とＹ偏波の強度を同一にしていた。従来のデポラライザの第１番目の媒質は等量のＸ、Ｙ偏波を作り出すためのものである。もしもほかに等量のＸ、Ｙ偏波を作り出すものがあれば、ひとつの複屈折媒質によって実効的にデポラライザとすることができる。

【００３２】光ファイバジャイロには、一般にスーパールミネッセントダイオードなどのコヒーレンス長の短い、干渉性の低い光源が用いられる。スーパールミネッセントダイオードはＬＥＤと同じ自然放出による発光と、レーザダイオードの誘導放出による発光の中間の状態で発光する。つまりスーパールミネッセントダイオードの発光は、自然放出と誘導放出の発光モードの組合せになっている。駆動電流により両者の比率が変化する。一般に発光パワーが低いときは自然放出が主であり、発光パワーが高い時は誘導放出が大きくなる。発光状態により前記の①、②が区別される。

【００３３】①　光源が自然放出によって発光する場合、この光は無偏光である。スーパールミネッセントダイオードを低パワーで駆動する時は、殆ど無偏光に近い発光になる。この場合、複屈折媒質の主軸の方位は（光軸に垂直な面内で）任意の方向であってよい。もともと無偏光に近いのであるが、Ｘ偏波とＹ偏波をコヒーレンス長以上引き離し、相互に干渉できないようにするのでより完全に無偏光になる。ここでＸ、Ｙ偏波というのは複屈折媒質の主軸の方向に偏光を持つといういうことで光源の偏光状態とは無関係である。

【００３４】②光源が主に誘導放出によって発光する場合これは直線偏光になる。偏光の方向は、素子の結晶学＊的方位によって決まる。この場合は、直線偏光の偏光方向と、複屈折媒質の主軸の方向が４５°を成すようにする。直線偏光の方向をＸＹ方向にするので、複屈折媒質の主軸に平行な偏光であるＸ偏光、Ｙ偏光に等しいパワーが配分される。これらの光が媒質を通りコヒーレンス長以上に離れるので、これ以後干渉しない。また任意の方向の偏光を持つ光の強度が等しくなるので無偏光になる。

【００３５】③　偏光子がなくても本発明の光ファイバジャイロはその機能を果たすことができる。しかし、偏光選択性をさらに良くするには、複屈折媒質の光源側（図４）に偏光子２０を設ければ良い。この場合、複屈折媒質の主軸が、偏光子の透過軸と４５°を成すように設定する。つまり複屈折媒質の結晶主軸ａ軸とｃ軸を、Ｘ軸、Ｙ軸方向にとると、直線偏光はＸＹ方向に偏波を持つようにする。②と同じように、Ｘ偏波とＹ偏波に同じパワーが配分される。これらが光源のコヒーレンス長以上の距離離れてしまう。直交偏光間で干渉が起こらず、直交偏波の光の強度が等しいので無偏光である。偏光子として通常の偏光子ではなく、特別な方位に設定した複屈折媒質を用いることもできる。

【００３６】②と③は他の部品が直線偏光を形成することを利用し、ひとつの複屈折媒質によりデポラライザと同じ機能を発揮するようにしたものである。

【００３７】

【実施例】図１の構成で、複屈折媒質としてバルクの光学結晶を例えば用いる。ルチル結晶、方解石、水晶などが利用できる。ここでは、方解石を複屈折媒質として用いた。常光線屈折率ｎ。＝１．６６、異常光線屈折率ｎ。＝１．４９である。屈折率差が０．１７であるので、光路長差ΔＬは、

【００３８】

$$\Delta L = 0.17L \qquad (4)$$

【００３９】となる。光源としてスーパールミネッセントを用いたとする。典型的な例としてコヒーレンス長Ｌｃが５０μｍのものを採用する。するとコヒーレンス長※より長い光路長差を与えるには、

$$0.17L > 50\mu m \qquad (5)$$

【００４１】である。すると、方解石の長さＬは

$$L > 294\mu m \qquad (6)$$

【００４２】であればよい。ごく薄い方解石結晶で良いことが分かる。光源のコヒーレンス長がより長い場合はそれに応じて、結晶を長くする必要がある。（１）式により簡単に計算できる。

【００４３】複屈折媒質として、偏波保持光ファイバを★用いることもできる。複屈折率Ｂ＝$n_x - n_y$が分かっているので、必要なファイバの長さを計算できる。例えば標準的な偏波保持光ファイバの複屈折Ｂは5×10^{-4}である。この場合は、

【００４４】

$$0.0005L > 50\mu m \qquad (7)$$

$$L > 100mm \qquad (8)$$

【００４５】となる。つまりこの偏波保持光ファイバであれば。０．１ｍ程度で足りる。十分に短くて、コスト高にならない。もしも通常のデポラライザを作ろうとすると、これの２倍の長さの偏波保持光ファイバをもう１本必要とし、これらを、異方性方向が４５度の角度を成すように精密に融着接続しなければならない。本発明は

ファイバは１本で済み、精密な融着接続も不要である（ただしシングルモードファイバ２との接続は必要である）。

【００４６】図４のように偏光子２０を、複屈折媒質の前または後に設ける場合は、偏光子の透過軸と、複屈折媒質の主軸を４５°傾けるようにする。偏光子は偏光プリズムのようなものでもよいし、金属誘電体多層膜でも良い。あるいはファイバ型偏光子を用いることもできる。

【００４７】あるいは図６のように異方性軸（ｃ軸）を前方４５°方向に傾けた別の複屈折媒質２１を用いてもよい。後の複屈折媒質１１が、本発明で主要な働きをしている複屈折媒質である。光の進行方向をＺ方向（Ｚ＝ｂ）とすると、複屈折媒質１１の異方性軸はＸ軸又はＹ軸に平行である（Ｘ＝ａ、Ｙ＝ｃあるいはＸ＝ｃ、Ｙ＝ａ）。しかし前の複屈折媒質２１は偏光子と同じように一方の直線偏光のみを取り出すためのものである。常光線（実線）は直角入射であるので、そのまま直進する。異常光線（破線）は直角入射であるにも拘らず、複屈折の分だけ経路が屈折する。

【００４８】これは複屈折媒質の異方性軸（ｃ軸）が、光の進行方向（Ｚ方向）に対して４５°傾いている時に特に顕著に起こる現象である。等方軸（ａ軸、ｂ軸）の方向は任意である。異常光線の直角からのずれの角度Θは、ｃ軸がＺ方向に対して４５°の角度を成すとき、屈折率の差を複屈折の平均で割った値になる。Θ＝２（ｎ。－ｎ。）／（ｎ。＋ｎ。）。複屈折媒質が十分の厚さを持てば、光軸から外れてしまった異常光線は光ファイバに入らない。

【００４９】ここで常光線というのは、偏波がｃ軸成分を持たないということで定義できる。ａ軸単位ベクトルとｂ軸単位ベクトルの差の方向に、偏光を持つ直線偏光である。直線偏光の方向は確定する。異常光線はｃ軸方向にも偏光成分を持ち、伝搬方向と常光線の偏光に直交する偏光を持つということによって定義される。常光線だけが以後複屈折媒質１１を通り光ファイバに入る。つまり、常光線と異常光線を空間的に分離する。このためにはじめの複屈折媒質２１は、偏光子と等価な作用を持つ。反対に異常光線のみをファイバに通し、常光線をファイバの外に追い出すということも可能である。いずれでも良い。これは、本発明者の提案になる特願平５－２０８６８３号「偏光選択素子、光源モジュール及び光ファイバジャイロ」に詳しく説明してある。

【００５０】２つめの複屈折媒質はこれに対して、これまでに説明してきたものと同じ方向に設置する。ｂ軸がＺ方向を向く。ａ軸、ｃ軸がＺ方向に直角である。第１の複屈折媒質からでた直線偏光（第１複屈折媒質のａベクトルとｂベクトルの差の方向）に対して、ａ軸、ｃ軸ともに４５°の角度を成すように設置する。

【００５１】

【発明の効果】本発明者が先に提案した「光源から信号を取り出す光ファイバジャイロ」（特願平５－５７７５６号）において、ファイバコイルをシングルモードファイバとするとデポラライザが必要であった。本発明は、ひとつの複屈折媒質を光源とファイバの間に設けるだけでデポラライザと同じように光を無偏光に変換することができる。高価な偏波保持光ファイバを２本、異方性軸が４５°を成すように融着接続するという、複雑で、不安定で、難しい工程を省くことができる。これにより、低コストの光ファイバジャイロを製造することができる。

【図面の簡単な説明】

【図１】本発明の光源から信号を取り出す光ファイバジャイロの原理構成図。

【図２】本発明者が先に発明した光ファイバジャイロ（特願平５－５７７５６号）の原理図。

【図３】２本の偏波保持光ファイバを異方性軸が４５°異なるように融着接続してデポラライザとする従来例に係るデポラライザの概略図。

【図４】本発明の光ファイバジャイロの他の構成を示す概略原理図。

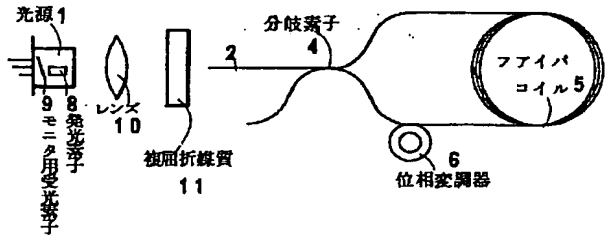
【図５】本発明において複屈折媒質の作用を説明するための図。

【図６】偏光子と等価なものとして複屈折媒質を用いた例を示す概略構成図。

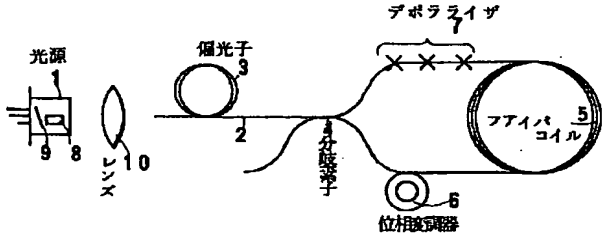
【符号の説明】

１　光源
２　シングルモードファイバ
３　偏光子
４　分岐素子
５　ファイバコイル
６　位相変調器
７　デポラライザ
８　発光素子
９　モニタ用受光素子
１０　レンズ
１１　複屈折媒質
２０　偏光子
２１　複屈折媒質

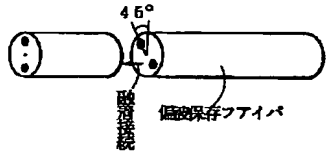
【図１】



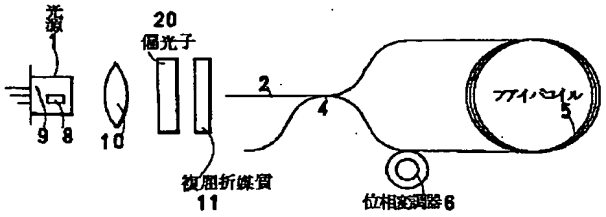
【図２】



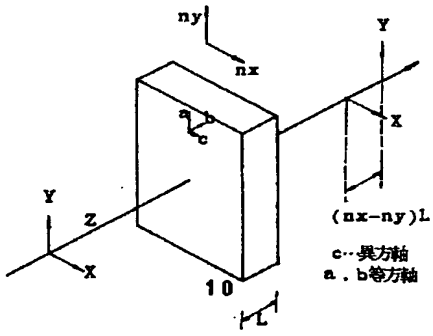
【図３】



【図４】



【図５】



【図６】